

François N. Diederich: Pioneer of carbon allotropes and molecular recognition

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François Nico Diederich, an iconic organic chemist who innovated and created in the fields of molecular recognition and host–guest chemistry, new allotropes of carbon and novel carbon-rich molecules, and drug activity and design, passed away on September 23, 2020 in Zurich, Switzerland at the age of 68, after battling an aggressive cancer.

A proud native of Luxembourg, Diederich became known the world over both for his chemical discoveries and for his warm, lively, and interactive personality. Educated first in Luxembourg and then earning his diploma and doctorate at the University of Heidelberg, Germany with Heinz Staab, Diederich gained early fame for the first synthesis in 1978 of a hydrocarbon that Staab had named “Kekulene” to honor the discoverer of the structure of benzene.

Kekulene, containing 12 fused benzene rings in a planar circular structure, was resynthesized and studied by single-molecule imaging in 2019, and found to have the structural details predicted by Diederich and Staab. By conquering the synthesis of this molecule, Diederich became enamored of carbon-rich molecules that he studied throughout his career.

Diederich was a postdoctoral fellow with Orville L. Chapman at the University of California, Los Angeles (UCLA) from 1979 to 1981, and had fruitful interactions with Donald Cram, UCLA professor, who was on his way to the Nobel Prize in 1987 for host–guest chemistry. This field was another one in which Diederich became a world leader. Both of us (K.N.H. and J.F.S.) had similarly memorable educational interactions with Cram (and with Diederich!) at various times in our careers. As reflected in his garb in the photo taken in the Chemistry Library at UCLA in 1980, Diederich was a very active and successful football (soccer) player at the time! This sport and daily reading of novels occasionally took his mind off chemistry, but not for long.

Diederich returned to Germany and earned his habilitation at the Max Planck Institute for Medical Research in Heidelberg. Diederich later said of that experience that the “broad interdisciplinary learning and research environment . . . from organic chemistry



François N. Diederich. Reproduced with permission from ref. 1.

to physics, to biophysics, molecular biology and physiology” are reflected in his diverse lifelong research interests.

Diederich returned to UCLA as an associate professor in 1985, rising to full Professor of Organic and Bioorganic Chemistry at UCLA in 1989. François and I (K.N.H.) joined UCLA at the same time (I was about 10 years his senior). Being his colleague and friend was a life-expanding experience for me, professionally and personally. We published six papers together at

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The authors declare no competing interest.

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First published December 21, 2020.



François Diederich in the Chemistry Library at UCLA, 1980. Image credit: Marion C. Peters (Librarian Emeritus, University of California, Los Angeles, CA).

UCLA and four more over our careers, each an adventure in chemistry together. The papers were in two areas in which he made his mark in the chemical world. One was in the area of fullerenes (C_{60} and related aromatic spherical carbons), which his postdoc mentor Orville Chapman had sought for many years to produce by rational synthesis. Kroto, Curl, Smalley, and coworkers characterized C_{60} (called "Buckminsterfullerene") in 1985, and in 1990 Krätschmer, Fostiropoulos, and Huffman showed how to make useful amounts from a carbon arc. Diederich and his group, especially his student Yves Rubin, now a professor at UCLA, did much of the early chemistry on this remarkable substance. At the same time, Diederich studied other allotropes of carbon and first made C_{18} , which I had the pleasure of calculating and publishing with him, predicting that it has alternating single and triple bonds in a single 18-membered ring.

I (J.F.S.) first crossed paths with the remarkable young scientist, François Diederich, in 1989 when his paper on C_{18} in *Science* (2) attracted my attention, and I wrote a "News and Views" in *Nature* on this achievement (3). Coincidentally, Diederich's *Science* paper (2) was written with my coauthor, K.N.H. In agreement with their predictions, the monocyclic alternating triple and single bond structure was recently verified by single-molecule imaging. Diederich also made major inroads into the quantitative understanding of host-guest chemistry, measuring binding

energies, and performing calorimetry and careful physical studies, learning the critical role of solvation effects on host-guest binding.

No sooner had I accepted the editorship in 1989 of a new Royal Society of Chemistry Series of Monographs on Supramolecular Chemistry than I reached out to François, by then at UCLA, to write the first monograph, *Cyclophanes* (4). It was published in January 1991, setting a high bar for subsequent authors, including Donald and Jane Cram, who wrote about *Container Molecules and Their Guests* following the Diederich layout (5). I published five papers with François Diederich over a 22-year span from 1997 to 2018. I find the first paper to be the most memorable one since it heralded a contemporary merger between catenane and fullerene chemistry (6). Coincidentally, it was the first paper with my UCLA address on it when I moved there. François' approach influenced my lifelong research into the nature of host-guest complexation and novel supramolecular constructs.

Diederich did so well in 7 years at UCLA that in 1992 he was appointed Professor of Organic Chemistry at Eidgenössische Technische Hochschule (ETH) Zurich. I (K.N.H.) had become the Chair of our department at UCLA in 1991 and was hoping he would stay at UCLA, but there was nothing we could do to keep him back from his lifelong dream of being a professor at arguably the greatest university for organic chemistry, certainly in Europe, but probably in the whole world. His two young children, Christophe and Cathérine, were forced to import their skateboards and California paraphernalia to Zurich.

In his fruitful career at the ETH, Diederich became world-renowned for his work in organic materials and host-guest chemistry, but his interests also moved into drug design. Visitors to him in the early 21st century witnessed his great delight at showing images of proteins in a special room with his three-dimensional (with glasses) "beamer" (European for "video projector") to explain how drugs fit into binding sites of proteins. Through what he termed his "chemical-structure-intuition-based approach," Diederich successfully helped develop an understanding of the action of pharmaceuticals for malaria, shigellosis, and African sleeping sickness, and advised the Hoffman-La Roche company on new directions in drug design.

Throughout his career, beginning with his university and doctoral education and habilitation, Diederich had a strong association with the outstanding chemical community of Germany. He served various functions, including board membership, with the German Chemical Society (Gesellschaft Deutscher Chemiker), which eventually bestowed him with their highest recognition, Honorary Membership, in March of 2019. He was also the Chair of the Advisory Board for the important and influential journal, *Angewandte Chemie*, from 2004 to 2013, and a member of the advisory board of BASF.

Diederich retired on July 31, 2017, as required in the Swiss system, but remained a research-active professor and consultant. He returned to UCLA several times

to give lectures and to collaborate with chemistry and biochemistry faculty at UCLA and at United States companies and universities. In April 2019, Diederich, accompanied by his wife Georgine, visited UCLA to honor his UCLA postdoctoral mentor with the 2019 Orville L. Chapman Lecture.

In June of 2019, the ETH group organized the International Francois Diederich Farewell Symposium, which was held to honor Diederich upon his full retirement from research at ETH Zurich. It was attended by many former group members, scientific collaborators from all over the world, and many fans of his chemistry from the ETH and elsewhere. Not long after that, after an extended vacation—maybe the first real vacation of his life—he was struck by the cancer that took his life.

François Diederich leaves behind accomplishments documented in over 800 publications and carried on by numerous scientific offspring in academia and industry all over the world. He was honored worldwide with numerous awards, including the United States, German, and Spanish National Academies of Science, European Academy of Sciences and Art, several awards from the American Chemical Society, including Cope Scholar and Breslow Biomimetic Chemistry Awards, honorary membership in the Israel Chemical Society, and an officer of the Order of Merit of the Grand Duchy of Luxembourg.

We have lost a close friend and scientific giant. On a more personal note, J.F.S. remembers: “He helped Norma and [me] with our transition from Birmingham



François and Georgine Diederich at UCLA in 2019. Image credit: Penny Jennings (University of California, Los Angeles, CA).

in 1997 to UCLA, which he had left only a few years earlier yet continued to visit frequently with his family for many years. There was no one in my big circle of friends in the chemistry community quite like François. He bubbled over with enthusiasm when it came to his love of chemistry and his family. Then, there was that unique twinkle in his eye when he was sharing a little secret with you or telling a joke to a larger audience. I will miss him greatly and many like me will miss him in that same vein as well.”

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